Docket No. 02-1166

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

APPEAL NO. _____

First named inventor: Wayne J. Hamilton

Confirmation No. 5390

Serial No. 10/715,697

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Examiner: Terence Boes

Art Unit: 3682

Title: LOW ANGLE INTERSECTING AND SKEW FACE GEAR

APPEAL BRIEF

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1. REAL PARTY IN INTEREST

The real party in interest is the assignee, The Boeing Company.

2. RELATED APPEALS AND INTERFERENCES

No appeals or interferences are known to have a bearing on the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 1-6 and 11-13 are cancelled.

Claims 7-10 and 14-16 are pending.

Claims 7-10 and 14-16 are rejected.

The rejections of claims 7-10 and 14-16 are being appealed.

4. STATUS OF AMENDMENTS

An amendment was filed subsequent to the final rejection dated 1 April 2009. The after final amendment, dated 1 July 2009, was entered and overcame a rejection under 35 USC §112, second paragraph.

5. SUMMARY OF CLAIMED SUBJECT MATTER

Claim 7

Base claim 7 recites a machine. An example of the machine is illustrated in Figure 5. The machine comprises a first shaft 70, a spur gear 62 mounted to the first shaft 70, a second shaft 72, and a face gear 20 including a hub mounted to the second shaft 72 (page 4, lines 12-18). The first and second shafts have an angular variance greater than zero degrees (page 4, lines 14-16). As shown in Figures 1-3, an angled gear flange 30 surrounds the hub 24, and a plurality of gear teeth 32 are on the gear flange 30 (page 3, lines 15-24). The face gear 20 is in mesh with the spur gear 62 (page 4, lines 16-17).

As shown in Figure 4, a first vector Ng normal to an outside surface of the angular flange 30 and a second vector Vp normal to the second shaft 72 form an angle that is equal to the angular variance 48 of the first and second shafts 70 and 72 (page 4, lines 4-11). The so-called criticality here is that by angling the gear flange 30 at the angle recited in claim 7, the face gear 20 can achieve line contact with the spur gear 62 (page 4, lines 25-26). This overcomes a problem with cross axis helical gears on shafts having a small angular variance. The helical gears make contact at a point and thus take the full load of the gear (page 1, lines 25-26). Because the point takes the full load of the gear, the gear is made larger and heavier to handle the full load.

Claim 10

Claim 10 depends indirectly from claim 7. Claim 10 recites the machine of claim 7, further comprising an engine for driving the first shaft 70 and a transmission driven by the second shaft 72 (page 4, line 14), wherein the engine

and transmission are a rotary aircraft engine and transmission (page 4, lines 14-16).

Claim 15

Base claim 15 recites an assembly. An example of the assembly is illustrated in Figure 5. The assembly comprises first and second shafts 70 and 72 that are non-parallel, a spur gear 62 on the first shaft 70; and a face gear 20 on the second shaft 72 (page 4, lines 12-18). The face and spur gears 20 and 62 are in constant mesh (page 4, lines 16-17). The face gear 20 includes a hub 24 on the second shaft 72, an angled flange 30 around the hub 24, and gear teeth 32 on the angled flange 30 (Figures 1-3 and page 3, lines 15-24). The flange 30 is angled so the face gear 20 achieves line contact with the spur gear 62 when the gears are in mesh (page 4, lines 25-26).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

a. Rejection of claims 7, 9 and 15 under 35 USC §102(b) as being anticipated by Ovshinsky U.S. Patent No. 2,967,980.

b. Rejection of claims 7-10 and 14-16 under 35 USC §103(a) as being unpatentable over Yokel U.S. Patent No. 3,803,934 in view of Ovshinsky U.S. Patent No. 2,967,980.

c. Rejection of claim 10 under 35 USC §103(a) as being unpatentable over Yokel U.S. Patent No. 3,803,934 in view of Ovshinsky U.S. Patent No. 2,967,980 and Stone U.S. Patent No. 3,942,387.

7. ARGUMENTS

All pending claims recite a face gear. A face gear is a term of art. It is a different type of gear than a spur gear or a bevel gear or a helical gear. The Appendix section includes a copy of a web page from

http://www.engineersedge.com/gears/gear_types.htm

which describes and differentiates face gears, spur gears, bevel gears and helical gears. The copy of the web page was made of record as part of the response filed on 26 Jan. 2009.

I

REJECTION OF CLAIMS 7, 9 AND 15 UNDER 35 USC §102(B) AS BEING ANTICIPATED BY OVSHINSKY U.S. PATENT NO. 2,967,980

Ovshinsky discloses a power steering mechanism for a vehicle. Figures 10-11 and col. 8, lines 58-75 describe a steering wheel having upper and lower sections 300 and 302. A sleeve 306 is connected to the lower section 302, an annular flange 310 surrounds the sleeve 306, and bevel teeth 312 are formed at a periphery of the flange 310. The bevel teeth engage a pinion gear 314 at the end of a power output shaft 304.

The office action alleges that element 306/310/312 is a face gear, but Ovshinsky does not support the allegation. Ovshinsky describes element 306/310/312 as a bevel gear (col. 8, lines 72-73).

Moreover, the element 306/310/312 does not have a first vector normal to an outside surface of an angular flange 310 and a second vector normal to the shaft section 302 to form an angle that is equal to the angular variance of the first and second shaft sections 302 and 304. Ovshinsky is silent about these vectors.

Ovshinsky does disclose a face gear 122 at column 7, lines 31-39. As shown in Figure 8, the face gear 122 is fixed to a transfer shaft 124, and a bevel gear 126 is fixed to the other end of the shaft 124. The bevel gear 126 engages another bevel gear 128 (col. 7, lines 33-34), and pinion gears engage the face gear 122 (col. 7, lines 26-30).

Ovshinsky is silent about a face gear having an angled flange. Ovshinsky does not teach or suggest the flange angle recited in base claims 7 and 15. Ovshinsky does not disclose any modifications to a standard face gear 122.

Thus, Ovshinsky does not disclose a machine having all of the features recited in base claims 7 and 15. Therefore, the '102 rejection of claims 7, 9 and 15 should be withdrawn.

II

REJECTION OF CLAIMS 7-10 AND 14-16 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER YOKEL U.S. PATENT NO. 3,803,934 IN VIEW OF OVSHINSKY U.S. PATENT NO. 2,967,980

The key to supporting any rejection under 35 U.S.C. §103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in KSR International Co. v. Teleflex Inc. noted that the analysis supporting a rejection under 35 U.S.C. §103 should be made explicit. "Rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness" (citations omitted).

Yokel discloses a transmission that transmits power to an inclined propeller shaft 4. The transmission includes a bevel gear 18 that is journaled on an input shaft 10. The bevel gear 18 is of the tapered helical type, having a front end of smaller diameter [than its back end] (column 3, lines 57+). The transmission

further includes an output shaft 40, which is inclined at approximately 7 degrees of horizontal. A large tapered helical gear 44 on the output shaft 40 is in constant mesh with the bevel gear 18 (column 3, lines 26+).

Claims 7-9 and 14-16

Yokel does not disclose face gears. Yokel proposes two tapered helical gears that are in constant mesh to transmit power between non-parallel shafts 10 and 40.

Ovshinsky does not teach or suggest using a face gear in place of Yokel's helical gears. Ovshinsky does not teach or suggest a face gear having an angled flange as recited in either base claim 7 or base claim 15. Ovshinsky uses bevel gears to transmit motion between shafts 302 and 304 having an angular variance.

Therefore, the combined teachings of Yokel and Ovshinsky do not produce a machine having all of the features recited in base claim 7 or an assembly having all of the features recited in base claim 15. For this reason alone, the '103 rejection of claims 7-9 and 14-16 should be withdrawn.

The '103 rejection of claims 7-9 and 14-16 should be withdrawn for the additional reason that the office action does not provide articulated reasoning to support obviousness. It does not provide any reasons for replacing Yokel's helical gears with Ovshinsky's bevel gears. It does not even take into account that Yokel's assembly has different operational and structural requirements than Ovshinsky's assembly (turning a propeller versus turning a steering column).

The office action merely provides a bald conclusion of obviousness. It concludes that the combined teachings of Yokel and Ovshinsky would produce "predictable" results.

Claim 10

Neither Yokel nor Ovshinsky discloses a transmission for a rotary aircraft. Yokel discloses a transmission that transmits power to an inclined propeller shaft 4. The combined teachings of Yokel and Ovshinsky do not produce a machine having all of the features recited in claim 10. Therefore, the '103 rejection of claim 10 should be withdrawn.

Ovshinsky's element 306/310/312 is designed for a different purpose than the face gear of claim 10 (turning a steering column versus transmitting shaft power from an engine). Ovshinsky's gears are designed for far, far lower loads and speeds than a helicopter transmission. Point contact between gears might not be a problem with turning a steering column. Point contact between helical gears might not even be a problem in turning a propeller. Both Ovshinsky and Yokel are silent about point contact between gears. Ovshinsky does not provide underpinnings that would suggest replacing Yokel's helical gears.

Moreover, the office action merely provides a bald conclusion of obviousness It concludes that the combined teachings of Yokel and Ovshinsky would produce "predictable" results.

The '103 rejection of claim 10 should be withdrawn for the additional reason that the office action does not provide articulated reasoning to support obviousness.

III

REJECTION OF CLAIM 10 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER YOKEL U.S. PATENT NO. 3,803,934 IN VIEW OF OVSHINSKY U.S. PATENT NO. 2,967,980 AND STONE U.S. PATENT NO. 3,942,387

Of the three documents cited in the '103 rejection, only Stone discloses a helicopter transmission. Stone discloses a helicopter transmission including a power input shaft 12 that carries a beveled pinion 18, and an angled power output shaft 32 that carries a bevel gear 30 (col. 2, lines 11-38). The bevel gear 30 meshes with the pinion 18. Stone is concerned about gaining access to critical units in a gearbox (col. 1, lines 19-28), not point contact of the gears 18 and 30.

The office action alleges that Stone discloses face gears. Stone does not. Gear 30 is a bevel gear.

Ovshinsky also discloses bevel gears for transmitting power between non-parallel shaft sections 302 and 304. Yokel discloses the use of helical gears to transmit power between non-parallel shafts. Thus, none of the cited documents suggests using a spur gear and a face gear having an angled flange. That is, the '103 rejection of claim 10 is not supported by rational underpinnings.

The office action does not provide a clear articulation as to how the teachings of Stone and Ovshinsky would be used to modify Yokel's propeller drive. It appears to allege that Stone suggests using Ovshinsky's element 306/310/312 to drive Yokel's propeller. However, the allegation is not clear.

Ovshinsky's gears are designed for a different purpose than the face gear of claim 10 (turning a steering column, not transmitting shaft power from an engine). Ovshinsky's element 306/310/312 is designed for far, far lower loads and speeds than Stone's helicopter transmission. Point contact between bevel gears might not be a problem with turning a steering column. Point contact between

helical gears might not even be a problem in turning a propeller. Both Ovshinsky and Yokel are silent about point contact between gears. So is Stone, and Stone relates to helicopter transmissions. Neither Stone nor Ovshinsky provides underpinnings that would suggest replacing Yokel's helical gears with a spur gear and face gear.

Even if the allegations in the office action are taken at face value, the machine produced by the combined teachings would include a transmission that transmits power to an inclined propeller shaft 4. It does not include a rotary aircraft engine and transmission. Thus, the combined teachings do not produce a machine having all of the features of claim 10.

Moreover, the office action does not provide a clear articulation of obviousness. The office action only provides a bald conclusion of obviousness. It concludes that the combined teachings of Yokel, Ovshinsky and Stone would produce "predictable" results.

Thus, the office action provides neither rational underpinnings nor a clear articulation to support the'103 rejection of claim 10. Therefore, the '103 rejection of claim 10 should be withdrawn.

For the reasons above, the rejections should be reversed. The Honorable Board of Patent Appeals and Interferences is respectfully requested to reverse the rejections.

Respectfully submitted,

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Date: Oct. 1, 2009

8. CLAIMS APPENDIX

1-6. (Cancelled)

7. (Previously presented) A machine comprising:

a first shaft;

a spur gear mounted to the first shaft;

a second shaft, the first and second shafts having an angular variance greater than zero degrees; and

a face gear including a hub mounted to the second shaft, an angled gear flange surrounding the hub, and a plurality of gear teeth on the gear flange, the face gear in mesh with the spur gear,

wherein a first vector normal to an outside surface of the angular flange and a second vector normal to the second shaft form an angle that is equal to the angular variance of the first and second shafts.

8. (Previously presented) The machine of Claim 7, further comprising an engine for driving the first shaft and a transmission driven by the second shaft.

9. (Previously presented) The machine of Claim 7, wherein the gear teeth of the face gear are formed by a precision grinding method.

10. (Previously presented) The machine of Claim 8, wherein the engine and transmission are a rotary aircraft engine and transmission.

11-13. (Cancelled)

14. (Previously presented) The machine of claim 7, wherein the first and second shafts have an angular variance of no more than 30 degrees.

15. (Previously presented) An assembly comprising:

first and second shafts that are non-parallel;

a spur gear on the first shaft; and

a face gear on the second shaft, the face and spur gears in constant mesh, the face gear including a hub on the second shaft, an angled flange around the hub, and gear teeth on the angled flange, the flange angled so the face gear achieves line contact with the spur gear when the gears are in mesh.

16. (Previously presented) The assembly of claim 15, wherein the first and second shafts have an angular variance of no more than 30 degrees.

9. EVIDENCE APPENDIX

Gear Types, Spur, Helical, Bevel, Rack and Pinion, Worm

Gear Products and Suppliers | Gear Knowledge Menu

Spur Gears:

Spur gears are the most common type used. Tooth contact is primarily rolling, with sliding occurring during engagement and disengagement. Some noise is normal, but it may become objectionable at high speeds.

Rack and Pinion.

Rack and pinion gears are essentially a linear shaped variation of spur gears The spur rack is a portion of a spur gear with an infinite radius.

Internal Ring Gear:

Internal gear is a cylindrical shaped gear with the meshing teeth inside or outside a circular ring. Often used with a spur gear. Internal ring gears may be used within a planetary gear arrangement.

Helical Gear:

Helical gear is a cylindrical shaped gear with helicoid teeth. Helical gears operate with less noise and vibration than spur gears. At any time, the load on helical gears is distributed over several teeth, resulting in reduced wear. Due to their angular cut, teeth meshing results in thrust loads along the gear shaft. This action requires thrust bearings to absorb the thrust load and maintain gear alignment. They are widely used in industry. A negative is the axial thrust force the helix form causes.

Helical Rack Gear:

Helical rack gears are linear shaped and meshes with a rotating helical gear.

Double Helical Gear:

Double helical gear may have both left-hand and right-hand helical teeth. The double helical form is used to balance the thrust forces and provide additional gear shear area.

Face Gear:

Face gears are a circular disc with a ring of teeth cut on one side. The gear teeth are tapered toward the center of the tooth. These gears typically mate with a spur gear.

Worm Gear:

Worm gears teeth resemblex ACME screw thread which mates with a helical gear, except that it is made to envelope the worm as seen along the worm's axis. Operation of worm gears is analogous to a screw. The relative motion between these gears is sliding rather than rolling. The uniform distribution of tooth pressures on these gears enables use of metals with inherently low coefficients of friction such as bronze wheel gears with hardened steel worm gears. These gears rely on full fluid film lubrication and require heavy oil compounded to enhance lubricity and film strength to prevent metal contact.

Double Enveloping Worm Gear:

The double enveloping worm gear has a radial changing pitch diameter. This increases

the number and amount of tooth shear area.

Hypoid Gear:

Hypoid gears are typically found within the differential (rear axle) of automobiles. The gear arrangement allows the translation of torque ninety degrees. Hypoid gears are similar to spiral bevel gears except that the shaft center lines do not intersect. Hypoid gears combine the rolling action and high tooth pressure of spiral bevels with the sliding action of worm gears. This combination and the all-steel construction of the drive and driven gear result in a gear set with special lubrication requirements, including oiliness and anti-weld additives to withstand the high tooth pressures and high rubbing speeds.

Straight Bevel Gear:

Straight bevel gears have tapered conical teeth which intersect the same tooth geometry. Bevel gears are used to transmit motion between shafts with intersecting center lines. The intersecting angle is normally 90 deg but may be as high as 180 deg. When the mating gears are equal in size and the shafts are positioned at 90 degrees to each other, they are referred to as miter gears. The teeth of bevel gears can also be cut in a curved manner to produce spiral bevel gears, which produce smoother and quieter operation than straight cut bevels.

Spiral Bevel Gear:

Spiral bevel gears have a helical angle spiral teeth.

Screw Gear (Crossed Helical Gear):

Screw gears are helical gears of opposite helix angle will mesh when their axes are crossed.

10. RELATED PROCEEDINGS APPENDIX

None